CENTENNIAL HISTORY OF THE DEPARTMENT OF MINERALOGY

THE OHIO STATE UNIVERSITY

PART I

FOUNDING AND EARLY DEVELOPMENT

MINERALOGY AT THE OHIO STATE UNIVERSITY TO 1911

Although an independent department of mineralogy was not constituted until 1913, mineralogy was taught continuously from the first year of operation of The Ohio Agricultural and Mechanical College to the present time. Mineralogy is often regarded as a branch of the geological sciences, hence it is somewhat surprising to learn that mineralogy was never taught by the department of geology. Edward Orton, Sr., elected Professor of Geology, Mining and Metallurgy on January 2, 1873 by vote of the Board of Trustees, declined the position, but when, in April, 1874, the presidency of the College was tendered to him, he accepted both that post and the professorship of geology. It is significant that his title appears in the first circular and catalogue of the college, that of 1874-1875, as "Edward Orton, President of the College, Professor of Geology and Mineralogy." Although his choice of title indicates the esteem in which he held mineralogy, there is no evidence that Orton ever taught the subject other than as a part of the course in geology.

The first instruction in mineralogy was undertaken by the Department of Chemistry in the second term of the College's first year of operation; the academic year 1874-1875. "Blow-pipe mineralogy" is included among the subjects covered in the chemistry course, and Brush's Determinative Mineralogy is listed among books of reference used in the course. This widely known and respected textbook and laboratory manual for mineral identification by blow-pipe methods went into a 2nd Edition in 1875 and

a 3rd in 1878 and was almost universally used in American universities of the period. Its direct successor, Brush and Penfield's Manual for Determinative Mineralogy still enjoys a moderate circulation today.

This course was taught by Professor Sidney A. Norton, who may therefore be regarded as the first to teach mineralogy at what was shortly to become The Ohio State University. Professor Norton was born in Bloomfield, Trumbull County, Ohio in 1835 and received the degree of A.B. from Union College, New York in 1856, the degree of A.M. from the same institution in 1859, and the M.D. from Miami Medical College in 1869. He had studied chemistry in Germany at Bonn, Leipzig and Heidelberg, had served as Professor of Chemistry at Miami Medical College from 1867-1872 and was Acting Professor of Physics at Union College when he was called to the Professorship of Chemistry at Columbus by the vote of the first Board of Trustees in January, 1873.

In the course description of the Department of Chemistry for 1875-1876, it is asserted that:

> "In connection with the ordinary work of Qualitative Chemistry, the student is taught the use of the spectroscope and the blow-pipe in Determinative Mineralogy."

This curriculum, although modest in scope, seems to have been sufficiently inspiring to have captured the interest of one of the College's first students, one of the five members of the first graduating class. In the Report of the Board of Trustees for 1876, in relating the work of the Department of Chemistry in analysing soil and mineral sample submitted by miners, farmers and others, it is said that:

> "Professor Norton's report gives examples of these services in the quantitative analysis of a number of Ohio minerals, executed under his supervision by Mr. C. C. Howard, one of the students of the College."

Curtis C. Howard, who was among the five members of the first graduating class, that of 1878, received the degree of B.Sc. on June 20th, offering as his graduating thesis, "The Iron Ores of the Hocking Valley." His analyses of these ores were included in toto in the report of the Department of Chemistry to the Trustees in 1877, and represent not only the first thesis on a mineralogic topic, but the first original scholarly scientific results to emerge from the new Ohio State University. Howard was born in Franklin County in 1854, and after his graduation from The Ohio State University, did graduate work at The Johns Hopkins University, then returned to O.S.U. in 1881 to take the first M.Sc. degree granted by the University, and remained in Columbus as Professor Chemistry and Toxology (sic) at Starling Medical College, soon to become the College of Medicine of O.S.U.

In 1876, an Act of the legislature of Ohio established a Department of Mining Engineering, but, characteristically, neglected to provide any funds for the salary of a professor to staff it. On June 20, 1877, the Trustees met this emergency by the following resolution:

> RESOLVED: that the curriculum be changed by striking therefrom the Department of Political Economy and Civil Polity and substituting therefor the Department of Mines, Mining Engineering and Metallurgy.

This questionable expedient passed by a vote of 9 in favor to 4 opposed, and Professor William Colvin, of the now non-existent Department of Political Economy, etc., was out of a job. He sued to recover either his job or compensation from the University, but in vain.

Mr. Henry Newton was then unanimously appointed Professor of Mines, Mine Engineering and Metallurgy at the same salary as the other professors,

$225 per month. Professor Newton was fated never to take up his duties, as he visited the Black Hills during the summer of 1877 to complete some geologic investigations he had undertaken for the U.S. Government and there died of "mountain fever" (spotted fever?). The appointment was then offered to William E. Guy of St. Louis, who, after visiting the College, declined the offer. The position was then tendered to, and accepted by John A. Church, an experienced metallurgist and mining engineer, who was appointed effective November 1, 1877. In November, 1878, Professor Church wrote:

> "In addition to the special work of my department (NOTE: This was chiefly the performing of identifications and analyses for miners and businessmen.) I have undertaken to give a course in Mineralogy to the second year preparatory students. That class will number about forty members."

There were only five students altogether in "mineralogy, mining, ore and coal washing, and assaying" that first year, however, and Professor Church's position was a weak one. The mineralogy course he contemplated was to be the first taught under that title at O.S.U. In his 1878 report, Professor Church further related that he had spent, out of the appropriation of $2,736.51 made by the legislature for equipment for the new department of Mines, Mine Engineering and Metallurgy:

> "$589.14 for mineralogy and $46.50 for minerals including a student's collection of minerals."

Professor Church requested additional assistance in the conduct of the analyses, etc., for which he already had the services of Nat. W. Lord, who is listed in the faculty directory for 1878 as "Assistant in State Laboratory." The Trustees expressed their displeasure at having to pay for the services

of two to perform duties they conceived could be well enough performed by one, and Professor Church was unceremoniously discharged and replaced by the erstwhile assistant, N. W. Lord. This exchange effected a considerable "political economy," as Lord, who was getting $50 a month as an assistant, was increased only to $100 per month upon his elevation to the post of Assistant Professor of Mines, Mining Engineering and Metallurgy on June 18th, 1879. The Board of Trustees

> RESOLVED .... that Nat. W. Lord, M.E., be employed as Assistant Professor at a salary of $1200 per year.

Professor Church, who had been getting $225 per month, disappears from our history, and there is no evidence that he repeated the vain effort of Colvin to sue for satisfaction. Professor Lord's first report, dated November 1, 1879, says:

> "The class of preparatory students in the required course of Mineralogy was large, numbering thirty seven." (The unfortunate Church was a fairly good prophet.)
>
> "The mineral collections of the department have been increased by a fine set of crystal models, made under the direction of Professor Church last spring, and by minerals purchased from time to time."

The set of crystal models was made of wood, and are frequently alluded to with considerable pride in subsequent course descriptions, etc. Professor Church seems to have expended the $589.14 wisely. Some large wooden models still in the possession of the department may be part of this early set, and if so, the set was of excellent quality and the forms represented well chosen.

The catalogue entries for the academic year 1901-1902 are typical. The name of the Department has been changed to The Department of Metallurgy and Mineralogy with the creation of a separate department of Mining Engineering. The departmental office was in Room 5, Chemical Hall. The list of courses was:

2. Mineralogy — Three times a week.

Dana's Manual of Mineralogy and Lithology

Professor Lord

3. Determinative Mineralogy — Five times a week.

Brush's Determinative Mineralogy is used as a manual.

A laboratory course in practical determination of minerals by physical and chemical tests. Each student is furnished with a set of apparatus and works under an instructor's inspection.

Professor Lord and Mr. Somermeier

9. Mineral Chemistry — Five times a week.

Lectures upon fire-damp mine explosions, explosives, boiler waters, poisonous gases, iron ores, iron and steel, their properties and modes of manufacture; coal and coke.

Professor Lord

Mineralogy 2 is clearly the fundamental course in crystallography and mineralogy, whose content can be determined by examination of any edition of Dana's Manual from the 1860s to the 1920s. The determinative course, using blow-pipe techniques was a mainstay of mineralogy instruction up to the time of Word War II. Course 9 is the nitty-gritty of the engineer's business, and its content points up the contrast between the curriculum of the Engineering College and that of the Arts and Sciences in 1901.

Subsequent reports by Assistant Professor N. W. Lord follow.

On November 1, 1880:

"The class in Mineralogy numbered twenty-one. This is the only class in the department which is part of the regular college course for all the scientific degrees (underlining mine) and hence is necessarily larger than the purely technical courses."

On November 1, 1881:

"The freshman class in Mineralogy numbered twenty-two, making the total number of students in the department thirty-two."

On November 14, 1882:

"The freshman class in Mineralogy (spring term) contained twenty-eight students, making the total number in the department thirty-six"

Meanwhile N. W. Lord advanced to the rank of Professor (in 1881) with a salary of $2000 per annum. During these years he was in the curious position of being Chairman of a department of Mines, Mining Engineering and Metallurgy in which very few students took courses in any of these subjects, and with the bulk of his work and the preponderance of his enrollments in Mineralogy, to such an extent that he must constantly defend his other subjects in his reports to the Trustees.

In 1883, Professor Lord advertised his program as follows:

"An ample collection of minerals is provided, comprising all species with which the mining engineer should be familiar."

"Crystallography is taught by the aid of a complete collection of large wood models, made especially for the department and containing every common form."

"Textbooks: Dana's Mineralogy, Egleston's Crystallographic Tables, ----- von Cotta's Ore Deposits."

Although description of the facilities in mining and metallurgy were lengthier, the above excerpts indicate that mineralogy still bulked large in the program of the department, in spite of Professor Lord's efforts to build up the mining and metallurgy fields. The enrollments tell the story. In June, 1885, Professor Lord once again had to report:

"The department record for classes for the past year are as follows:

Metallurgy, assaying and other special studies	8
Mineralogy	50
This total includes no student twice.	58"

And again in 1886:

"The class in Freshman Mineralogy numbered forty-four, so that the whole number of students in the various classes in the department during the year was seventy-three. (This total included eight in blow-pipe analysis, which was counted separately from mineralogy.)"

Lord asked that the appropriation be liberal. Student supplies took $100 for the year, so $300 for "current expenses" he felt would allow him to "improve conditions greatly."

And again in 1887:

"Mineralogy (winter term)	57
Total for year	69"

The pattern of instruction in the Department of Mines, Mining Engineering and Metallurgy remains the same for the next several years, with mineralogy service teaching apparently occupying most of Lord's time. In 1896, Lord became Dean of the newly constituted College of Engineering, and changed his official title in the faculty list to: "Professor of Mineralogy and Metallurgy and Dean of the College of Engineering" in belated but significant recognition of the leading role mineralogy had played in his academic career to this time. For eighteen years, mineralogy had paid the bill for the continued activities of the Department of Mines, Mining Engineering and Metallurgy. Inasmuch as not one of his thiry published papers deals with a mineralogical topic, the association seems to have been a rather unwilling one, but such was the uncompromising honesty and sincerity of purpose of Prof. Lord, to which all his colleagues attested, we can assume that the job of teaching mineralogy, however distasteful, was well and truly done.

As Professor Lord became increasingly occupied with administrative tasks, the teaching duties in the department were shared by an assistant, Mr. Somermeier, who joined the faculty in 1898. Edward Ellsworth Somermeier took the degree of G.Ph. in 1898 at O.S.U., and with the exception of a brief period of service as a chemist with the U.S. Geological Survey, spent the rest of his career in the Department of Mines, Mining Engineering and Metallurgy, becoming, after the separation of the departments, Chairman of the Department of Metallurgy.

In the academic year 1896-1897, an unusual arrangement appeared. Two courses in mineralogy were given; one numbered 52.in the College of Arts, Philosophy and Science; the other, numbered 2., in the College of Engineering. The catalogue entries read as follows:

COLLEGE OF ARTS, PHILOSOPHY AND SCIENCE

52. Mineralogy Last nine weeks of second semester.

Lectures, with frequent quizzes on notes and with study of specimens in the collection of minerals. A short introductory course is given in crystallography, illustrated by wooden models. Textbook: Dana's Manual of Mineralogy and Lithology.

COLLEGE OF ENGINEERING

2. Mineralogy Three times a week.

Lectures similar to Course 52 in College of Arts, Philosophy and Science, but more practical, and arranged so as to be preparatory to Determinative Mineralogy (Course 3).

3. Determinative Mineralogy Five times a week.

Brush's Determinative Mineralogy

This division of the elementary mineralogy course, so prophetic of the future, lasted only two years. By the catalogue of 1900-1901, Mineralogy 52 has disappeared. In 1901, Professor Lord relinquished the post of Dean of the College of Engineering, but remained Chairman and Professor of Mines, Mining Engineering and Metallurgy until his death in 1911. During these years, the department had its quarters in Rooms 3, 4 and 5 Chemical Hall. The department occupied the eastern wing of the Chemical Hall and a large portion of the basement. A collection of minerals and rocks was provided for illustrating the lectures in mineralogy, and sets of special specimens were provided for the students in determinative mineralogy and blow-pipe work. The mineralogy lecture room was provided with a projecting lantern and a large number of slides illustrating the treatment of ores and metals. The list of courses given and their description remained essentially unchanged until Professor Lord's death in 1911.

Other courses in the department were of similar practical nature. A succession of junior fellows and assistants joined the department briefly for a short time; Niles Otis Ford in 1901-1902; a Mr. Spitler in 1902-1903; and C. E. MacQuigg, later to become Dean of the College of Engineering, in 1908-1909. It is rather pleasant to reflect that the present-day Department of Mineralogy teaches elementary mineralogy in a building named for a Dean who served at least a part of his academic apprenticeship in the mineralogy laboratory of Professor Lord.

During the acdemic year 1903-1904, a major catastrophe disturbed the placid course of events in the Department of Metallurgy and Mineralogy. Chemical Hall, which was occupied jointly by the Departments of Chemistry, Metallurgy and Mineralogy, and Pharmacy, was destroyed by fire on February 19th, 1904. The departments of Chemistry and Metallurgy and Mineralogy were temporarily located in Townshend Hall.

While the Department was in exile in Townshend Hall, awaiting the completion of the planned new Mines Building, the department was joined by Mr. Demorest as Assistant in Metallurgy and Mineralogy. Dana J. Demorest took his B.Sc. degree at O.S.U. and was to spend the rest of his life in the department of metallurgy, rising to full professorship. In October 1905, it was possible to state that the new Mines building was nearing completion, and in 1906-1907, the department was installed in its new quarters. "The School of Mines Building - This building, costing $85,000, accomodates the departments of Metallurgy and Mineralogy, Mine Engineering, and Ceramics ..... the equipment in mineralogy comprises a large mineral collection and a room for blow-pipe analysis and determinative mineralogy....." "12,000 square feel are devoted to Metallurgy and Mineralogy." During this year, Mr. Somermeier was

elevated to the rank of Assistant Professor, and in the following year, to Associate Professor. During the year 1908-1909 a course in Economic Mineralogy was added. In 1909-1910, the course numbers were changed; Course 2., Mineralogy, becoming 104., and Course 3. becoming 108. Mineral Chemistry, Course 9. became 102. Mr. Demorest was promoted to Assistant Professor.

On May 23, 1911, Nathaniel Wright Lord died, and an era came to an end.

SOME FACTS AND STATISTICS FROM THE McCAUGHEY ERA

Prior to his appointment to the post of Assistant Professor at The Ohio State University in the autumn of 1911, William John McCaughey had served as assistant assayer at the U.S. Bureau of the Mint from 1906 to 1908, and as a scientist with The U.S. Bureau of Soils from 1908 to 1911. In 1909 he served with the U.S. Assay Commission. His undergraduate work was done at the University of Pennsylvania, culminating in a B.S. degree in 1906. While employed with the U.S. Bureau of Soils, he continued his education, taking graduate courses at The Johns Hopkins University during 1909 and 1910, and continuing graduate work at George Washington University during 1910 and 1911. He received the degree of Ph.D. from George Washington University in 1912, after his appointment at The Ohio State University. He was author or coauthor of eight papers, one on a mineralogical subject, prior to his appointment at O.S.U.

In his first year of teaching with the Department of Metallurgy and Mine Engineering, the courses given were those that had been given for many years:

102. Mineral Chemistry

104. Crystallography and Mineralogy

108. Determinative Mineralogy

but to these were added two, given for the first time in 1911-1912, which indicated an attempt to take advantage of the special training of the newly appointed Professor McCaughey:

"117. Advanced Crystallography and Physical Mineralogy
3 cr. hrs. 1st Sem.
Two lectures and one lab. The study of the geometrical

and physical properties of crystals. Laboratory work on the measurement, calculation and projection of crystals and determination of physical and optical constants of crystallized bodies. Prereq.: Physics and Chemistry

118. Microscopical Mineralogy 3 cr hrs. 2nd Sem.

One lecture and two labs. The use of the polarizing microscope in the identification of minerals in fine powders and in thin section. Determination of the optical constants of minerals and crystallized bodies with a polarizing microscope. Prereq.: Met and Min 104, physics and chemistry."

These two courses constitute substantial and impressive additions to the curriculum. The first implies the possession or expected acquisition of a reflecting goniometer, and the second, polarizing microscopes. These are costly items of equipment and indicate real confidence in the powers and skills of the new appointee on the part of the administration.

The Department of Mineralogy makes its appearance as an administrative entity in the academic year 1913-1914, with an office in Room 104, in the former Mines Building, now named Lord Hall, in honor of the deceased Nathaniel Wright Lord. The emergence of the new department is further signalized by the addition of another new course, in microscopic petrography, and a reshuffle of course numbers. The course list in 1914 includes:

102. Crystallography and Mineralogy (Formerly 104.)

104. Determinative mineralogy (Formerly 108.)

121. Microscopic mineralogy (Formerly 117.)

124. Microscopic petrography (New course)

126. Advanced crystallography and physical mineralogy (Formerly 118.)

Mineral Chemistry, Met. and Min. 102., never a mineralogy course, was not

transferred to the new department.

In the academic year of 1914-1915 the first mention of possible graduate work in mineralogy appears in University publications. It is stated in the Catalogue for that year that:

> "Students desiring to undertake advanced work in this department should have a thorough working knowledge of chemistry, trigonometry, geology and mineralogy."

In the year 1916-1917, the course, Mineralogy 105. Physical Chemical Mineralogy, first made its appearance, and with it the future trend of specialization in the department was set. This is the course in the application of phase equilibrium diagrams and phase equilibrium methods of experimental mineralogy and petrology to geologic, ceramic and metallurgical problems that became so intimately connected with Professor McCaughey and with the O.S.U. Department of Mineralogy in the succeeding 35 years. It is interesting to note that the last two numerals designating this course have not changed over the many years that it has been taught, and that Mineralogy 605, taught today by Professor W. R. Foster, perpetuates, in modern form and with up-to-date methods and data, many of the philosophic fundamentals laid down by McCaughey, and continues to illuminate the problems of geology and engineering.

McCaughey was advanced to the rank of Professor in the academic year 1916-1917, without having passed through the rank of Associate Professor, a further tribute to the confidence and enthusiasm he inspired in his administrative superiors and associates. His salary in 1920 was $2750 per annum.

In the academic year 1918-1919, the title of Mineralogy 105 was changed to Thermochemical Mineralogy, the title it bears today. The name was invented by McCaughey in the interest of economy of words and to avoid

confusion with the numerous courses in physical chemistry taught in other departments. The course was taken at that time by Ceramic and Metallurgical Engineering students in their 4th year. A course in Elementary Microscopic Petrography, Mineralogy 111, was also added, and for the first time, a "research" course, or individual studies course, was listed; Mineralogy 131, Mineralogic Investigations. Under this umbrella number, four choices were listed: a. advanced crystallography b. microscopic petrography c. soil mineralogy and d. applied microscopic mineralogy. With some changes, this type of courses was to persist to the present day.

At this time, for the year ending June 30, 1920, enrollments were as follows:

First Semester		Second Semester	
102.	28	102.	60
105.	14	104.	7
113.	7	131.	2
121.	6	Total:	124

In 1921-1922, another course number shuffle changed the first digit to indicate the rank of courses, so that the offerings of the Mineralogy Department became:

Old	New		Old	New
102.	401.		105.	605.
104.	402.		111.	611.
	404.	Blowpipe analysis	131.	631.
(For undergraduates)			(For graduates or advanced under graduates)	

In the autumn of 1923, Arthur Marshall Brant was appointed as Instructor in Mineralogy to assist Professor McCaughey, who had been Chairman and sole staff member of the department since its formation, ten years before. Mr. Brant had been Graduate Assistant in the Chemistry Department during 1922-1923, and held the B.Ch.E. and M.Sc. degrees, both from The Ohio State University. During the summer quarter of 1924, summer courses in mineralogy were given for the first time by Mr. Brant. Min. 401. 402. and 404. were all offered.

In 1925-1926, the first indications of an actual graduate program make their appearance. Some additional advanced level courses were added, Mineralogy 601, Advanced Crystallography; Mineralogy 606., Advanced Thermochemical Mineralogy; Mineralogy 741., Thesis (Undergraduate); and "For Graduates Only," Mineralogy 801., 802., 803., Research. Shortly after this time, the first graduate student to take an advanced degree in mineralogy, Miss Helen B. Blair, took her Ph.D. degree. During this period, students in Metallurgical, Chemical and Mining Engineering took Mineralogy 401. and 402., students in Metallurgical and Mining Engineering also took 404. and 611., whereas Ceramic and Metallurgical Engineering students took Mineralogy 605.

In 1928, Professor Brant took his Ph.D. degree, also from The Ohio State University, and was advanced in rank to Assistant Professor. Reflecting what was perhaps a personal interest on the part of Professor Brant, a course, Mineralogy 400., Precious and Ornamental Stones, was added. The words "blowpipe analysis" were dropped from the course description of Mineralogy 404., the title of which became simply "Determinative Mineralogy," reflecting the tendency to view blowpipe

analysis and chemical testing of minerals as old-fashioned, and hence in disrepute. At the same time, the words "x-ray crystal analysis" made their appearance as a possible choice under Mineralogical Investigations, indicating either that an x-ray machine had been built or was being contemplated. That the x-ray machine was in fact built about this time is indicated by the fact that x-ray photographs dated in 1931 and 1932 still survive in the Department's files.

In the academic year 1932-1933, the course, Mineralogy 654., X-ray Crystal Structure Analysis, was added. The machine built at that time still survives. It makes use of a filament transformer and high-voltage transformer from a dental radiography unit, and embodies half-wave rectification using a separate rectifier tube. A water-cooled Machlett tube was used and controls for all functions were arranged on a six-foot rack panel. The unit was in actual use as late as 1960. X-ray crystal structure analysis was relatively new as a subject of instruction at that time and commercially built x-ray units were not generally available for diffraction work, so it was customary to convert or modify radiography equipment in this way. Some students who later pursued this field with distinction, such as Dr. Preston E. Harris, sometime Professor of Chemistry, The Ohio State University, received their first training in x-ray methods on this venerable hand-built machine.

Teaching duties were strenuous, loads were heavy and salaries small in this period. Professor McCaughey's salary during the academic year terminating June 30, 1930 was $5000, and that of Assistant Professor Brant was only $3000. The enrollments were heavy in the many courses taught, however.

Autumn		Winter		Spring		
401.	93	401.	18	401.	11	1929-1930
402.	7	402.	72	402.	12	
605.	14	606.	7	601.	4	
621.	11	631.	4	605.	35	Total:
631.	3			611.	25	323
				631.	1	
801.	1	802.	2	803.	1	
	129		103		91	

In 1935, Professor Brant was advanced to the rank of Associate Professor, a rank which he held until his retirement. By the academic year 1937-1938, enrollments had again nearly doubled in most courses.

Autumn		Winter		Spring		
401.	167(!)	401.	22	401.	28	1937-1938
402.	4	402.	127	402.	12	
				404.	11	
				601.	1	
605.	26			605.	30	
		606.	25			Total:
621.	29	611.	13			556
631	2	631.	14	631.	25	
		741.	1	741.	7	
950.	2(Research)	950.	2	950.	2	
		654.	6			
	230		210		116	

There was little change in curriculum and none in staff during the 1930s and 1940s, until in 1948 E. Joseph Weiss, B.Cer.E., and M.Sc., O.S.U., was briefly added to the staff as an Assistant Instructor in Mineralogy. He left in 1950, after receiving a Ph.D. in Mineralogy the previous year.

A report of survey of the property of the Department of Mineralogy made on March 1, 1951 revealed a total of $43,327.06 worth of equipment, including office furniture, that could be located. $297.54 worth was not located and was cancelled. This total valuation included all the petrographic microscopes that had been purchased for the courses in microscopic mineralogy and petrography, the reflecting goniometer, the x-ray equipment, photographic equipment and chemical equipment then on hand.

In October, 1950, the appointment of Duncan McConnell as Professor of Mineralogy became effective, and at the end of the academic year 1951-1952, Professor McCaughey retired. As Professor Emeritus of Mineralogy, he continued to occupy his former office and continued actively in his consulting work. Professor McConnell assumed the Chairmanship of the department upon Professor McCaughey's retirement, and the departmental office was moved to Room 140, Lord Hall. Professor Brant continued in his duties for another year, but the "McCaughey Era" had ended.

AN EVALUATION OF THE McCAUGHEY ERA

The year 1911 ushered in the second forty-one year span in the history of Mineralogy at Ohio State which can be no more appropriately designated than the "McCaughey Era." Upon the death of Nathaniel Lord on May 23, 1911, Professor E. E. Sommermeier became temporary head of the Department of Metallurgy and Mineralogy. It was only shortly thereafter that he undertook to add another mineralogist to the staff. In August of that year he invited Dr. William John McCaughey, a scientist with the U.S. Bureau of Soils in Washington, D.C., to become Assistant Professor of Mineralogy, with a commission to develop and "to have charge of all the mineralogy and petrography given at the University." Initially, he was to have responsibility for the assaying and ore dressing courses, which were to be relinquished to another staff member as the courses in mineralogy were developed. Dr. McCaughey accepted the offer, with its $1600 salary, and took up his duties in the autumn of 1911.

In welcoming the new Assistant Professor of Mineralogy, Dean Orton charged him "to take mineralogy out of the museum and put it to work." With the boundless enthusiasm so characteristic of the man, Professor McCaughey set out immediately to fulfill his mandate. He succeeded so rapidly and so well that in 1913 the College of Engineering set up a separate Department of Mineralogy with Dr. McCaughey as Acting Head. In 1916 he was promoted to Professor of Mineralogy and Chairman of the Department, a post which he held until his retirement in 1952.

From the outset the Department of Mineralogy operated on the premise that ceramic, chemical, and metallurgical engineers should have fundamental

training in crystallography, mineralogy, petrography, and phase equilibria in order to provide a sound background for industrial application of their knowledge. It was assumed, also, that this fundamental instruction should be provided by mineralogists rather than by engineers or geologists for whom mineralogy might hold only secondary interest. Professor McCaughey proved to be a most happy selection for the implementation of such a policy. Among other innovations the first formal course in this country in silicate phase equilibrium was instituted by him. He thus established himself as one of the first educators to recognize the value of thermochemical mineralogy in both geological and technological research.

But participation in the training of engineers was by no means the sole commitment accepted by Professor McCaughey and his Department of Mineralogy. Another obligation, discharged with equal dedication, was the instruction of students of Geology in the indispensable knowledge of crystallography, mineralogy, and petrography. In this, as in the training of engineers, he was ably assisted by his long-time associate, Dr. Arthur M. Brant, who served as his good right arm from 1923 until his own retirement with the rank of Associate Professor in 1953. Neither Professor McCaughey nor Dr. Brant, be it noted, was a geologist by training. It might therefore be supposed that they would be unable to serve to the fullest the mineralogical needs of the Department of Geology. But such a supposition would have been ill-founded. Professor McCaughey's two successors as chairman, both of them geologists, had ample opportunity to observe Professors McCaughey and Brant in the classroom and the laboratory. Both can attest to the high competence with which they met their teaching obligations to both material-science and earth-science students. Indeed, the very autonomy of the Department

of Mineralogy ensured that independence of domination from geologists on the one hand, or engineers on the other, which was a prerequisite to impartial fulfillment of its obligations to both disciplines. Perhaps the sagacious Dean Orton had this in mind when he first commissioned Dr. McCaughey to establish a department completely independent of the old Department of Metallurgy and Mineralogy. It is perhaps for this same reason that Mineralogy was never reassigned to a role as a secondary sub-division under the Department of Geology. At least moderate and occasional pressure in that direction was to be expected, since, in all but a few American universities, mineralogy was taught within departments of geology. Such an arrangement, it may be suggested, was more an historical accident than a compelling necessity, as witness the situation on the European continent, where separate departments of geology and mineralogy were, and still are, the rule rather than the exception.

During the entire forty-one years of his career at the University, Dr. McCaughey appears to have set as his major goal the establishment, in his department, of undisputed excellence in the performance of its service function. In this resolve he was eminently successful. His enthusiasm made mineralogy about the most exciting course in the various curricula in which it was prescribed. This was true whether he was expounding the theory of the behavior of silicates at high temperatures in the bowels of the earth, or shedding light on such problems as the behavior of slag in a blast furnace. It was immaterial, too, whether he was lecturing to geologists or to ceramic, chemical, or metallurgical engineers. On the other hand, he disclaimed any desire for, or interest in,

the establishment of a comprehensive mineralogy curriculum on either the undergraduate or graduate level. In this connection, it is reported that Dean Hitchcock, mightily impressed with the McCaughey magic in motivating students, offered to provide the staff, facilities and equipment necessary to make his "the best Mineralogy Department in the country, bar none." It is further reported that Professor McCaughey, after due deliberation, declined the Dean's offer, stating it to be his desire "to keep the department a small operation." As a consequence, no substantial graduate program in mineralogy was ever implemented, so that, during the entire McCaughey Era, only about seven Ph.D. degrees and five M.S. degrees were conferred in mineralogy. It was reserved for later times and later chairmen to undertake a serious and determined drive for a graduate program in Mineralogy. Regrettably, the magnanimous offer of Dean Hitchcock was never thereafter renewed. One can only wonder as to "what might have been," had Professor McCaughey's answer been in the affirmative.

But it would be erroneous to conclude that Professor McCaughey's teaching and example was restricted primarily to the few mineralogy graduate students he trained. Powerful though his influence was on these, it did not surpass the profound impact he had on thousands of students of other disciplines, both undergraduate and graduate, who came under his magic spell.

At the conclusion of the spring quarter of 1952, Dr. William John McCaughey, having reached the mandatory retirement age, assumed the rank of Professor Emeritus. Although he reamined unusually active in private consultation until his death on April 8, 1962, the McCaughey Era of the Department of Mineralogy can be said to have terminated with his retirement ten years before.

INTERLUDE

Upon his assumption of the chairmanship, Professor McConnell made few changes in the course offered, adding only one course in the first two years. This coursehowever, very signifcantly reflected his primary area of concern, in which he had attained distinction before coming to O.S.U., the field of crystal chemistry. The course, Mineralogy 755, Structure of the Silicate Minerals, was primarily designed for advanced students with proficiency in x-ray structure analysis and experience in the chemistry of minerals. The course endures today, as Mineralogy 655, but is now intended primarily for Ceramic Engineering undergraduates, and hence has fewer technical prerequisites.

In October, 1952, Wilfrid R. Foster joined the staff as Associate Professor of Mineralogy.

In the autumn of 1954, Alfred A. Levinson joined the staff as Assistant Professor of Mineralogy. Dr. Levinson was trained at the University of Michigan, and held the degrees of B.S., M.S. and Ph.D., all from that institution. Dr. Levinson had a strong personal interest in the mineralogy of gems, and restored to activity the course, Mineralogy 503, Mineralogy of Gems, and succeeded in obtaining gifts of much valuable gem material from jewellers to implement this course. He resigned his position in 1956 to enter industry.

It was under Dr. McConnell's chairmanship that plans were laid for an expanded graduate program in Mineralogy. Increasing demands from industry for well-trained mineralogists had led the department to reassess its function, which up to this time had been primarily one of

service to other disciplines. Although limitations of space, equipment and student-support would have to be overcome, the time appeared opportune for a more vigorous graduate-training program. Much-needed equipment was acquired in the form of two modern x-ray diffraction units and differential thermal analysis equipment. New research projects which would provide additional support for graduate students were arranged with the Ohio Geological Survey and the Edward Orton Jr. Ceramic Foundation, to augment the base of support provided by Professor McCaughey's long-standing Republic Steel Corporation research fund.

The acquisition of the services of Professors Foster and Levinson paved the way for the part-time assignment of Dr. McConnell as Assistant Dean of the Graduate School and enabled the appointment of an additional full-time staff-member. In October, 1954, to meet the increasing needs of the departments of mineralogy and geology, Ernest G. Ehlers was appointed as Assistant Professor of Mineralogy, with primary responsibility for courses in microscopy and petrology.

During the academic year ending June, 1956, the staff of the mineralogy department was considered to be at full strength, and

consisted of Professor and Chairman McConnell, Associate Professor Foster and Assistant Professors Ehlers and Levinson. Office of the department was in 140 Lord Hall and a total of 16 courses were taught:

Undergraduates	Undergraduates or graduates	Graduates
501. (old 401.)	601.	801.(Seminar)
502. (old 402.)	605.	950. Research
503. Mineralogy of Gems	621.	
506.(old 406.)	701. (old 631.)	
	706. (old 606.)	
	741.	
	754.	
	755.	

Professor McConnell resigned his chairmanship and his position as Professor of Professor Mineralogy December 31, 1956, becoming Research Professor of Dentistry in the College of Dentistry, a position which he still holds, and in which he actively pursues his pioneering research on the mineralogy of tooth and bone.

In October, 1957, the Department was completely reorganized. Dr. Foster was advanced to the rank of Professor and Chairman of the Department of Mineralogy; Dr. Ehlers was advanced to Associate Professor of Mineralogy, and two new men, Henry E. Wenden and Leslie C. Coleman were appointed. Dr. Coleman was a graduate of Queen's University, B.A., 1950, M.A., 1952, and held the degree of Ph.D. from Princeton University. He was a specialist in economic geology and had done field work in the Giant Yellowknife region of Canada. He resigned his position at O.S.U. in the spring of 1960, and is at present teaching geology at the University of Saskatchewan.

An important change in the teaching of elementary mineralogy was made in 1958-1959. A new course, Mineralogy 511-512, a two-quarter sequence for geology undergraduates, was added; Mineralogy 506, a one-quarter course, was revised to provide better coverage for engineering undergraduates, and the old 501-502 sequence was dropped. In this way, the different interests and needs of engineering and geology students could best be met. In 1960, Professor Coleman left, and in October, 1960, Rodney T. Tettenhorst was appointed as Assistant Professor of Mineralogy. Thus, at the beginning of the academic year 1960-1961, the composition of the department was the same as it is today except for the addition of another staff member, Professor Dan McLachlan, who joined in 1965, and the reappointment of the former chairman, Professor Duncan McConnell, on a one-sixth time basis for the direction of graduate research without teaching or administrative duties. The biographies of all present staff members are given as a part of a later section of this history.

THE MATURE YEARS

The twelve years of the Foster chairmanship began during the academic year 1956-1957 with the department reduced to two staff members following the resignation of Professor McConnel and Assistant Professor Levinson. There were no graduate students in residence. Professors Foster and Ehlers carried the entire service teaching load during the latter part of that year.

Twelve years later, during the academic year 1968-1969, the staff of the Mineralogy Department consisted of four full Professors, one Associate Professor, one part-time Research Professor and four graduate Teaching Assistants. Graduate students in residence or candidates for an advanced degree who had completed residence totalled twenty-two, and this number, which fluctuates as candidates receive their degrees, had reached a high of twenty-four during the Foster chairmanship. The space allocated to the activities of the Department of Mineralogy in 1956 totalled less than 6000 square feet, and consisted of six rooms, a small office occupied by Emeritus Professor McCaughey, and some basement storage in Lord Hall. In 1968-1969, the Department occupied a total of over 13,000 square feet consisting of six research laboratories and two offices in the Metallurgical Engineering Building, four instructional and three research laboratories, a museum, a storage room and a preparation laboratory in MacQuigg Hall, as well as three faculty offices, a Departmental office, numerous graduate students offices, a conference room, a laboratory and a storage room in Watts Hall.

Research equipment available in 1969 includes numerous x-ray diffraction units, high-temperature furnaces of many kinds, high-pressure equipment for both dry and hydrothermal investigations, crystal growth equipment, atomic absorption and x-ray emission spectrograph units for chemical analysis, numerous petrographic microscopes and other optical equipment, and, in general, nearly every facility that a well-equipped mineralogical laboratory requires.

Still more remarkable than the growth of the Mineralogy Department in staff and facilities, and far more a matter of pride to its staff, is the output of holders of advanced degrees. During the twelve years of the Foster administration, including two doctorates and two Master's awarded at the end of the Summer Quarter, 1969, the Department has produced twenty-one Doctors of Philosophy and a number of Masters of Science, many of whom went on to take the Ph.D. degree. If this number is added to the seven Doctors of Philosophy and nine Masters of Science produced by the forty years of the McCaughey administration, the total of twenty-eight Ph.D.s in the field of Mineralogy (as contrasted with Geology) is one unlikely to be matched by any 20th Century American institution of higher education, other than Harvard University. Independent degree-granting departments of instruction in Mineralogy have always been the rule in England and on the Continent, and this is still the case. During the 19th Century, such independent departments of Mineralogy were numerous in the United States. It is only during the 20th Century in the United States that a tendency to reduce the number of independent departments of instruction has resulted in the absorption of formerly autonomous Departments of Mineralogy

by departments of geology or chemistry. The success of the numerous graduates of this department indicates that this sacrifice of educational scope and quality to administrative expediency was an unfortunate one.

The Foster chairmanship has been productive also in a research sense. All members of the staff have contributed to national and international professional journals, three books have been published, and research grants have been held from the National Science Foundation, the National Institute of Health, the Mershon Institute, the Wright-Patterson Air Force Research Facility, Owens Corning Fiberglas, the American Chemical Society and other sponsors. Two have been granted U.S. patents for inventions.

Members of the staff have been honored in various ways. All have been active in, and most have held office in their professional societies; as, the Council of the Mineralogical Society of America; Chairman of Session, Clay Minerals Group; Secretary, Teaching Commission of the International Mineralogical Society, etc. One has received the $1000 Alumni Award for Distinguished Teaching; two the Engineering College Award of $300 for Meritorious Teaching; one, the Neil Miner Award for Teaching in the Geological Sciences; one, a Fulbright Fellowship to the University of Utrecht, and other honors and awards.

A notable achievement of Professor Foster's was the obtaining of a grant of over $50,000 from the National Science Foundation for the construction of enlarged research facilities. Generously matched by the State of Ohio with nearly twice this amount, these funds helped to construct the extension of then planned Metallurgical and Chemical

Engineering Building which includes the six research laboratories and two offices still in use by the Department.

Another example of forward-looking administration of the present department, is the now-terminated, but highly successful Joint Advanced Degree Program with Miami University. This estimable institution, although possessed of a fine Department of Geology, was unable at the time to grant the Ph.D. degree. By agreement with the Department of Mineralogy, suitably qualified graduate students were enabled to pursue their regular program of studies at Miami, supplementing them by attendance at O.S.U. classes, and carrying out dissertation research under joint supervision of Miami and O.S.U. Degrees were actually awarded by The Ohio State University. This program expedited the granting of permission for Miami University to award the Ph.D. degree in Geology and Mineralogy and brought to the field some fine young scholars whose subsequent success leaves no doubt as to the wisdom of the program.

The twelve years of the Foster chairmanship have also brought considerable expansion of the functions of the department, in the form of new courses, most of which represent professional specialties and technical skills not previously taught on this campus in any form. Thus, new courses have been offered in:

Clay Mineralogy

The Universal Stage and Petrofabrics

High-Pressure Mineralogy

Hydrothermal Mineralogy

Crystal Growth

Crystal Physics

Crystal Structure Analysis

The Microscopy of Opaque Minerals

The History of Mineralogy

and other subjects, some modifications of earlier courses. A Seminar in Mineralogy has been required of all graduate students in residence, and is a valuable part of the instructional program. Students find that their skill in public speaking and presentation of technical topics is improved by constructive criticism and continuing guidance and evaulation.

A unique enterprise of the Department of Mineralogy was the furnishing by the four members of the department of joint consulting services to the Owens Corning Fiberglas Pioneering Laboratory in Granville, Ohio for four years, from 1960 through 1964. By prior arrangement between Professor Foster and the late Games Slayter, Director of the Pioneering Laboratory, the proceeds from this consulting, amounting to $48,000, were paid into a special account administered by the Engineering Experiment Station of The Ohio State University rather than to the individual consultants. These funds were then used by the members of the Department for the purchase of needed equipment, not otherwise obtainable. A complete x-ray diffraction unit with high-angle goniometer and x-ray emission spectrograph was purchased from this fund, as were units for hydrothermal synthesis of minerals, high-temperature phase equilibrium studies, high-pressure mineralogical investigations and other valuable pieces of equipment used by the department both for research and instruction.

An interesting use of part of these funds was in the building of a collection of over 300 early books, important in the study of the history of mineralogy. This activity is continuing at the present time with photocopying of rare works, not purchasable in the usual way.

The department was greatly enriched by the advent of Professor Dan McLachlan, Jr., who came to O.S.U. as a Visiting Professor of Metallurgy and stayed as a Professor of Mineralogy. Professor McLachlan's profound scholarship is widely known and has won him international recognition, but his mechanical ingenuity and artistic talent are less common knowledge. He brought to completion the prototype of his invention, the Deep-field Microscope, after joining the department. This instrument has been patented and is being manufactured and sold at the present time. Both the remarkable photographs taken with this instrument and Professor McLachlan's original oil paintings ornament the walls of the department.

Indispensable to the smooth operation of the department is its beloved and capable secretary, Mrs. Henry Wuichner, who joined the staff in 1965 and whose many talents have proved invaluable.

The history of the past twelve years has been one of growth: physical growth in facilities and equipment; educational growth in number and variety of courses offered and in the number of advanced degrees conferred; administrative growth in personnel and rank; professional growth in number of publications produced, honors and distinctions gained, offices held; growth in the riches that only the passing years can bring, friendship within the department, the wisdom and experience of its members, and the loyalty and good wishes of the many students, now far dispersed, who remember their years in the Department with pleasure.

PART V

CURRENT STATUS OF THE DEPARTMENT OF MINERALOGY

The Department of Mineralogy offers graduate training at the M.S. and Ph.D. levels, in both Earth Science and Material Science areas as follows:

(a) Geological Mineralogy (Mineralogy directed towards the Earth Sciences)

Laboratory and field problems in igneous, metamorphic and sedimentary petrology.
Phase equilibrium investigations of rock-forming minerals.
Hydrothermal and high-pressure research.
Problems in ore-deposition and mineral paragenesis.
Industrial mineral deposits of Ohio, such as salt, clays and dolomites.
Studies in silicate mineral structures (clays, micas, etc.).

Joint programs with the Department of Geology may be arranged.

(b) Technological Mineralogy (Mineralogy directed towards Material Science)

Application of mineralogical knowledge to technological problems, primarily through the principles of phase-equilibrium and crystal-chemistry, and the techniques of polarized-light microscopy and x-ray diffraction.
Fundamental studies in solid-state chemistry, having significance for ceramic refractories, metallurgical slags, chemical catalysts, single-crystal electrical devices, etc.

Joint programs with the Departments of Ceramic, Chemical, Electrical and Metallurgical Engineering are possible.

B. Staff of the Department of Mineralogy

WILFRID R. FOSTER — Professor and Chairman

Education:
B.S. (Chemistry) University of New Brunswick, 1934
M.S. (Chemistry) Catholic University of America, 1936
Ph.D. (Geology) University of Chicago, 1940

Experience:
Instructor in Geology, Catholic University of America, 1940-1941
Instructor of Mining, Pennsylvania State University, 1941-1942
Petrographer, Champion Spark Plug Company, 1942-1952
Associate Professor of Mineralogy, The Ohio State University 1952-1957
Professor and Chairman of Mineralogy, The Ohio State University, 1957-

Teaching Interests: Thermochemical mineralogy
Physicochemical petrology

Research Interests: High-temperature phase-equilibrium investigations related to petrology and technology.

DAN McLACHLAN, Jr. — Professor

Education:
B.S. (Industrial Chemistry) Kansas State University, 1930
M.S. (Physical Chemistry) Pennsylvania State University, 1933
Ph.D. (Physical Chemistry) Pennsylvania State University, 1936

Experience:
Physical Chemist, Corning Glass Works, 1936-1940
Researcher, American Cyanamid Company, 1941-1947
Research Scientist, Stanford Research Institute, 1953-1961
Coordinator of Physics, University of Denver, 1961-1962
Professor of Metallurgy, University of Denver, 1962-1963
Visiting Battelle Professor of Metallurgy, The Ohio State University, 1963-1964
Professor of Mineralogy, The Ohio State University, 1964-

Teaching Interests: Crystal growth, crystal physics, structure of minerals

Research Interests: Principles of Crystal Growth

DUNCAN McCONNELL — Professor

Education:
B.S. (Chemistry) Washington and Lee University, 1931
M.S. (Geology) Cornell University, 1932
Ph.D. (Geology) University of Minnesota, 1937

Experience:
Instructor in Geology, University of Texas, 1937-1940
Chemist-Petrographer, Bureau of Reclamation, 1941-1947
Section Chief, Gulf Research and Development Corp., 1947-1950
Professor of Mineralogy, The Ohio State University, 1950-1956
Professor of Dentistry, The Ohio State University, 1957-
Professor of Mineralogy, (Part-time) The Ohio State University, 1964-

Research Interests: Mineralogy of teeth and bone; structure of apatite, garnet and analcime groups.

HENRY E. WENDEN — Professor

Education:
B.S. (Geology) Yale University, 1938
M.A. (Mineralogy) Harvard University, 1951
Ph.D. (Mineralogy) Harvard University, 1958

Experience:
Instructor in Geology, Boston University, 1949-1953
Assistant Professor of Geology, Tufts University, 1953-1957
Assistant Professor of Mineralogy, The Ohio State University, 1957-1961
Associate Professor of Mineralogy, The Ohio State University, 1961-1963
Professor of Mineralogy, The Ohio State University, 1963-

Teaching Interests: Elementary mineralogy and crystallography; ore-microscopy; x-ray crystallography; crystallochemical mineralogy.

Research Interests: Mineral paragenesis and crystal chemistry of mineral groups; growth and properties of single crystals.

ERNEST G. EHLERS — Professor

Education:
M.S. (Geology) University of Chicago, 1950
Ph.D. (Geology) University of Chicago, 1952

Experience:
Geologist, New Jersey Zinc Company, 1952-1954
Assistant Professor of Mineralogy, The Ohio State University, 1954-1957
Associate Professor of Mineralogy, The Ohio State University, 1957-1965
Professor of Mineralogy, The Ohio State University, 1965-

Teaching Interests: Optical Mineralogy, igneous and metamorphic petrology, ceramic petrography

Research Interests: Hydrothermal and ultra-high pressure mineral synthesis and stability, mechanism of growth of crystals.

RODNEY T. TETTENHORST — Associate Professor

Education:
B.S. (Geological Engineering) Washington University, 1955
M.S. (Geology) Washington University, 1957
Ph.D. (Mineralogy) University of Illinois, 1960

Experience:
Research Mineralogist, Pure Oil Company, Summers 1959, 1960, 1961
Assistant Professor of Mineralogy, The Ohio State University, 1960-1965
Associate Professor of Mineralogy, The Ohio State University, 1965-

Teaching Interests: Mineralogy in material science; clay mineralogy.

Research Interests: Structure and properties of the clay minerals and other layer silicates; clay-organic complexes; mechanism of crystal growth.

C. The "New Look" in Mineralogy

During the past 50 years Mineralogy has been undergoing a revolutionary transition. From an essentially descriptive science, serving primarily as the "hand-maiden" of the geologist, curator, and prospector, it has become also an interpretative discipline, and plays an increasingly important role in the many aspects of Earth Sciences. In addition, Mineralogy has assumed an ever more significant role in modern Material Science. Indeed, Mineralogy has been taken out of the museum and put to work, and it has directed its unique and fruitful viewpoints to the consideration of many fundamental problems of solid-state materials and technology.

The Department of Mineralogy at The Ohio State University has been a recognized pioneer in the development of the "new" mineralogy. Ever since its inception in 1913 the department has been active in promoting this modern approach. Currently the department is undertaking an accelerated research program in keeping with its early tradition of forward-looking mineralogical research. During the period from 1957 to the present, the graduate program of the department has undergone a striking expansion, both in intensity and diversity of effort. Within this period more doctoral candidates have been in training than during the preceding fifty years of the department's existence.

The present and contemplated activities of the department include efforts in several important phases of modern mineralogical research, including studies in high-temperature thermochemical mineralogy, the growth and properties of single crystals, the geochemistry and crystal chemistry of hydrous minerals, high-pressure relationships, clay mineralogy, and hydrothermal mineral synthesis and stability studies. Graduate students will thus participate actively in some of the more significant mineralogical and crystallographic aspects of Earth Science and Material Science. Some of these activities are outlined in the next section.

D. Major Areas of Graduate Research

1. Geological Mineralogy and Petrology (Field and Laboratory Studies): E. G. Ehlers, H. E. Wenden, R. T. Tettenhorst, W. R. Foster

All members of the staff of the Department of Mineralogy maintain an active interest in such traditional aspects of mineralogy as the occurrence and association of minerals in their natural habitats. Typical of the projects which have recently received the attention of staff-members and graduate-assistants are:

(a) The mineralogy of the salt deposits of Ohio, which are eliciting new interest, with the recent opening of two salt-mines in northern Ohio.

(b) Studies of the bloating characteristics of Ohio shales for possible use in light-weight aggregate; investigation of the possible beneficiation of Ohio clays with the aim of upgrading these clays for ceramic use; correlation of chemical composition, optical properties, x-ray diffraction patterns and differential thermal analysis behavior of selected Ohio clays.

(c) Mineralogical aspects of the acid mine water problem: discovery of halotrichite in acid mine water deposits; electron-microscope studies of the mechanism of oxidation of pyrite and marcasite; discovery of fossil sulfide-forming bacteria of Pennsylvanian age.

(d) Investigations on Ohio dolomites and limestones: the clay mineralogy of the shaly portions of the Brassfield limestone; discovery of hyexahydrite as a common efflorescence mineral on Ohio dolomites.

(e) Studies of the Serpent Mound "cryptovolcanic" structure in southern Ohio to secure additional high-pressure mineral evidence for the alleged meteorite-impact origin of the structure.

(f) Petrologic studies of igneous rocks from Marie Byrd Land, Antarctica, and of igneous rocks collected by deep-sea dredging of the Mid-Atlantic Ridge.

(g) Investigation of the mineralogy and mode of formation of concretions found in Ohio shales.

2. High-Temperature Phase Equilibrium Studies (Thermochemical Mineralogy), W. R. Foster

One of the most fruitful areas of fundamental research in Mineralogy has been the study of equilibrium relations of mineral mixtures (natural or synthetic) based upon the phase rule of J. Willard Gibbs. Focal point for the inception of American research in this area was the Geophysical Laboratory of Carnegie Institution of Washington, established in 1906. Within five years of that date, the late Professor William J. McCaughey initiated instruction and research in this vital area at The Ohio State University, thus becoming a pioneer in the educational aspects of the new discipline. Activity has continued in this area ever since.

Basically, the discipline involves the comprehensive study of solid-state stability, compatibility, and melting relations existing in chemical systems over wide ranges of temperatures and pressures. Special techniques and specialized equipment have of necessity been developed to meet the demands of this exacting undertaking. There is scarcely an area of Earth Science or Material Science which has not benefited markedly, or which can so benefit, from this dependable approach to physico-chemical equilibrium.

Such diverse problems as the origin of rocks and mineral deposits, the internal structure of the earth, the nature of meteorites, the technology of Portland Cement, the nature of metallic alloys, the performance of refractories, the extraction of chemical substances from raw materials, and a host of others, have all yielded most satisfactorily to this approach.

Much fundamental work remains to be done on both the more common and the rarer elements, their intermetallic compounds, their oxides, silicides silicates, borides and borates, nitrides and nitrates, sulfides and sulfates, carbides and carbonates, phosphides and phosphates, etc. Much old ground, too, needs to be re-ploughed as improved techniques permit more precise experiments. The Department of Mineralogy currently has half-a-dozen separate fundamental studies of this nature, in progress, under both governmental and industrial sponsorship.

3. Growth and Properties of Single Crystals (Crystal Growth):
Dan McLachlan, Jr., E. G. Ehlers, R. T. Tettenhorst, H. E. Wenden

There is perhaps no area of Material Science which is receiving more concentrated attention than that of crystal growth. The stringent requirements of today's technology give rise to an incessant demand for new and improved materials. The fundamental properties of a wide variety of crystalline materials are being examined or reexamined in the light of these needs. Particular attention is being focussed, then on metallic and non-metallic single crystals. The ever-increasing list of applications of such single crystals include optical devices, instrument-bearings, gems, controlled frequency oscillator plates, magnetic devices, semi-conductors, crystal-fiber insulation, and lasers and masers for light and microwave amplification by stimulated emission of radiation. The availability of suitable single crystals lags considerably behind the demonstrated or suggested applications. Governemnt, industrial and university research laboratories are directing increasing efforts towards closing the gap.

A program has been initiated for single crystal production in the Department of Mineralogy. Initially the crystal growth project is directed to the production of rare earth doped crystals of various non-metallic calcium compounds (fluoride, tungstate, carbonate, silicate, titanate, phosphate, etc.) Ultimately it is hoped to supply metallic and non-metallic crystals vitally needed for research in our own and other interested departments. The facility would thus perform a strong interdisciplinary function in some of the more active and significant areas of Material Science. All of the major crystal growth methods -- flame-fusion, crucible-lowering, crystal-pulling, zone-refining, flux-fusion, hydrothermal, vapor-deposition, floating-zone, etc. -- will come in for attention. The project will provide material for fundamental studies of crystal properties and crystal-growth mechanisms by both faculty and graduate students. It should accelerate the training of experts in an area characterized by rapidly increasing demand yet negligible supply.

4. High-Pressure, High-Temperature Synthesis
E. G. Ehlers

One of the primary current research interests of the Department is the synthesis and stability relations of crystalline solids under pressure. Substantial portions of the earth's crust have crystallized from silicate melts under hydrous conditions. A wide variety of minerals are formed in the presence of or distinctly affected by the presence of water vapor under pressure. Other minerals, forming at depth in the earth's mantle are strongly affected by extremely high pressures resulting from the weight of the overlying rock masses.

In addition to significantly affecting most rock-forming processes, high-pressure techniques are becoming increasingly important in technology. The growth of zeolites for chemical purposes, quartz crystals for communications, and diamonds for abrasive processes are just a few of the many applications.

The Department of Mineralogy has recently installed equipment for hydrothermal studies, as well as a "belt" apparatus for research up to approximately 80,000 atmospheres. Studies are in progress on stability relations in hydrous systems as well as high-pressure phase transitions. Investigations have begun on mineral synthesis of copper-lead oxychlorides under hydrothermal conditions. It is expected, that this area of study will play a key role in the crystal growth program outlined in the preceding section.

5. Geochemistry and Crystal Chemistry of Hydrous Silicate Minerals (Clay and Mica Research): R. T. Tettenhorst

A primary objective of this investigation to date has been the determination of the details of composition and structural variation of montmorillonite clay minerals, and the relation of these variations to physical and chemical properties. Studies such as these are necessary to understand fully any mineral group. As a consequence of the exceedingly fine particle size of montmorillonites, indirect methods have been utilized to obtain fundamental information that can be interpreted in terms of structure and composition.

Certain anomalous thermal behavior of montmorillonites previously described as mono-minerallic was shown to be due to the presence of at least two kinds of montmorillonite which are mixed randomly on a unit cell scale and which differ appreciably in their chemical composition. Techniques involving chemical treatment of the clays were developed to modify the phases differentially in order to observe their idnividual characteristics.

The nature of the reaction of montmorillonites with various organic and inorganic compounds is under investigation. Infrared spectroscopy has been employed to determine the extent and location to which cations move into the montmorillonite structure. Information concerning the mechanism by which organic molecules are bonded to clay minerals has been obtained from infrared and high-temperature x-ray techniques. Results of these investigations should lead to improved methods of identification of clays in addition to providing significant data on the reaction of organic and inorganic substances.

6. History of Mineralogy
H. E. Wenden

One of the most conspicious gaps in university instructional programs in the sciences in general, and in mineralogy in particular, has been in the field of the history and philosophy of the subject. This is a particularly serious omission in mineralogy, inasmuch as it is among the most ancient of sciences. As the mother of both crystallography and analytical chemistry it has played a very significant part in the scientific revolutions of the 18th and 19th centuries. The role of mineralogists has been and still is of the greatest significance in the origin of the science of crystals, in the development of the art and science of analytical chemistry, the growth of crystals, the formulation and formalization of concepts of space lattices and point groups, and the development of the science of crystal analysis and structure determination by x-ray, electron, and neutron diffraction.

A course in the history of mineralogy has been offered in the department of mineralogy, in alternate years, since 1965-1966. The department has acquired more than 300 books dealing with the early developments in mineralogy. Additions are being constantly made to this nucleus which, it is hoped, will eventually become a recognized center of information in the History of Mineralogy. Research in this area is already under way, and has resulted in the preparation and presentation of several original studies in this field. It is anticipated that a number of acceptable M.S. theses will be forthcoming from this project.

7. Crystal Structure Determination
Dan McLachlan, Jr. and H. E. Wenden

Since the pioneering work of the Braggs in the early 1900's, one of the most fascinating and rewarding research areas in crystallography has been that of the determination of the precise manner in which atoms are arranged in crystals. Two Nobel prizes, one in 1915 (W. H. and W. L. Bragg) and the other in 1964 (Dorothy Crowfoot Hodgkin) have rewarded investigators in this field. Intense activity in this area embraces all types of crystalline materials, be they natural or synthetic, metallic or non-metallic, organic or inorganic. The benefits which have accrued from such studies in solid-state physics, materials science, and biochemistry have been incalculable.

The department of mineralogy is well-equipped, through its own facilities and those of sister-departments, to conduct sophisticated crystal structure analysis research. Patterson function, vector-conversion, Karle-Hauptman, and inequalities methods of structure determination are employed, with utilization of available computer techniques. Natural minerals, as well as newly discovered compounds synthesized in our laboratories, are currently being investigated.

E. Major Items of Equipment in Department of Mineralogy

Comprehensive student and reference collection of minerals and rocks.

Convenient library facilities, with excellent coverage of the mineralogical literature, both geological and technological.

Microscopic equipment, including petrographic microscopes, photomicrographic equipment, ore-microscopes, double variation apparatus, Abbe' refractometer, universal stages, comprehensive rock and mineral thin-section collections.

McLachlan-Electronics and Alloys deep-field microscope.

Crystallographic equipment, including two-circle reflecting goniometers; Liebold and Krantz crystal models, styrofoam crystal lattices, collection of natural and synthetic single crystals.

X-ray diffraction equipment (4 units), with Laue, Weissenberg and Precession cameras, high-temperature x-ray furnaces, and recording geiger-counter, scintillation counter, and pulse-height analyzer attachments.

Electron-microscope.

X-ray fluorescence analyzer.

Atomic absorption spectrophotometer.

Differential thermal analysis and thermogravimetric analysis units.

Laboratory research furnaces, including strip-furnace, quenching furnaces, hydrothermal furnaces, induction furnace, globar furnaces, etc.

Crystal growth equipment, including units for flame-fusion, flux-fusion, Stockbarger, Czochralski, arc-image, zone-refining, and aqueous solution methods.

Hall "belt" apparatus for high-pressure mineral synthesis.

Cutting, grinding and polishing equipment.

Computer facilities and electron microprobe unit available by arrangement.

F. Assistantships and Fellowships in Mineralogy

1. Departmental assistantships and fellowships, including:

   a. Half-time graduate teaching assistantships
      Stipend: $2500 for nine months service and waiver of tuition
      Duties: 12 to 16 hours service per week, largely as teaching assistant in undergraduate mineralogy, crystallography optical mineralogy laboratories; service may include a few hours as research assistant to faculty-members.

   b. William J. McCaughey Fellowship
      Stipend: $2500 for nine months, and waiver of tuition
      Duties: Satisfactory academic standing in a full-time program of graduate studies
      This fellowship is in memorial to the late Professor William J. McCaughey, founder and for 35 years chairman of the Department of Mineralogy

   c. Edward Orton Jr. Ceramic Foundation Fellowship
      Stipend: $2500 for nine months, and waiver of tuition
      Duties: Half-time research in high-temperature mineralogy.

d. Several half-time research assistantships
Stipend: $2,700 for nine months; possibility, in some cases, of $300 per month (half-time) during summer months, and waiver of tuition
Duties: 20 hours per week service on government, industrial or faculty-research projects.

Renewal of these appointments depends on satisfactory performance of duties, and maintenance of a satisfactory academic record.

For application forms for any of the above assistantships and fellowships, write to: Chairman, Department of Mineralogy, The Ohio State University, 104 West 19th Avenue, Columbus, Ohio 43210.

2. General Fellowships administered by the Graduate School, including:

a. University Fellowships
Stipend: $2,000 for nine months; remission of tuition and laboratory fees
Tenure: First-year graduate students only; non-renewable
Duties: Full-time program of graduate studies.

b. *NSF Graduate Traineeships
Stipend: $2,400 to $2,800 for calendar year; annual dependency allowance of $500 for each dependent, up to $1,000; remission of all academic fees
Tenture: Twelve months
Duties: Full-time program of graduate studies.

* Appointees must be citizens of the United States

For application forms for either of the above, write to: Dean of the Graduate School, The Ohio State University, 164 West 19th Avenue, Columbus, Ohio 43210.

c. *NSF Graduate Fellowships
Stipend: $2,400 to $2,800 for calendar year; annual dependency allowance of $500 for each dependent, up to $1,000; remission of all academic fees
Tenure: one or two acdemic or calendar years
Duties: full-time program of graduate studies

*Appointees must be citizens of the United States

For application forms, address inquiries to: Fellowship Office, National Academy of Sciences, National Research Council, 2101 Constitution Avenue N.W., Washington, D.C. 20418.

G. Procedures for Helping Mineralogy Graduates to Secure Positions

The availability of positions becomes known in the following ways:

a. Letters directed to staff-members of the Departments of Geology and Mineralogy, advising of opening for mineralogists.

b. Visits to the campus by personnel representatives of industrial corporations.

c. Advertisements and announcements appearing in the earth-science and technology journals.

d. Announcements sent by the Department of Mineralogy to colleges and industrial corporations, advising of the availability of graduates.

In recent years the demand for graduate mineralogists has considerably exceeded the supply. As a result, each graduate has been able to choose from as many as six different positions.

H. Typical Positions of Recent Mineralogy Graduates

The following list provides a good indication of the types of positions available to recent graduates in Mineralogy:

a. Supervisor of Laboratories, Mexico Bureau of Mines, Mexico City, Mexico

b. Head, Crystal Chemistry Section, Highes Aircraft Corporation, Malibu, California

c. Senior Ceramic Scientist, Monsanto Chemical Company, Everett, Massachusetts

d. X-ray Crystallographer, National Cash Register Corporation, Dayton, Ohio

e. Petrographer, Ford Research Center, Dearborn, Michigan

f. Crystallographer, Lawrence Radiation Laboratories, Livermore, California

g. Mineralogist, U.S. Bureau of Mines, Norris, Tennessee

h. Research Investigator, Ceramic Section, Wright-Patterson Air Force Base, Dayton, Ohio

i. Assistant Professor of Mineralogy, Department of Geology, University of Iowa, Iowa City, Iowa 52240

j. Petrographer, A-C Spark Plug Division, General Motors Corporation, Flint, Michigan

k. Staff Research Manager, Corning Glass Works, Corning, New York

l. Mineralogist, Battelle Memorial Institute, Geneva, Switzerland

m. Mineralogist, Linde Division Union Carbide Corporation, Tonowanda, New York

n. Research physicist, Central Research Laboratories, E. I. du Pont de Nemours and Company, Wilmington, Delaware

o. Electron microscopist, College of Dentistry, The Ohio State University

p. Postdoctoral fellow, National Bureau of Standards, Washington, D.C.

q. Postdoctoral fellow, Department of Geology and Mineralogy, Queens University, Kingston, Ontario, Canada.

As the above list suggests, there are considerably more openings for trained mineralogists in technology than in geology-based activities. This trend is likely to continue and to be accentuated, due to the increasing recognition, by industry, of the unique and fruitful approach to technological problems through mineralogical techniques.

Not reflected in the above list is the availability of a considerable number of teaching positions in mineralogy and petrology. For a number of reasons, not the least of which is the salary-differential, few of our graduates have expressed an active interest in such teaching positions. It is of interest, nevertheless, that such positions are to be had.

Dr. Richard L. Barrett	Department of Chemistry New Mexico State University Las Cruces, New Mexico 88001
Dr. William C. Beard	Assistant Professor Department of Geology Cleveland State University Cleveland, Ohio 44115
Dr. John D. Birle	Development Engineer General Electric Company Worthington, Ohio 43081
Dr. Jerry W. Blake	Research Associate Equine Research The Ohio State University 43210
Dr. Marvin L. Britton	Staff Research Manager Corning Glass Company Corning, New York
Dr. John C. Butler	Assistant Professor Department of Geology University of Houston Houston, Texas 77004
Dr. William C. Butterman	Research Physicist E. I. DuPont deNemours and Company Wilmington, Delaware 19898
Mr. Kuan Huan Chang	425 North Huntington Avenue Monterey Park, California 91754
Mr. Allen Cichanski	Assistant Professor Department of Geology Eastern Michigan State University Ypsilanti, Michigan 48197
Mr. Samuel Coldwell	(Manager, Continental Can Company) 276 Buttonball Glastonbury, Connecticut
Dr. Robert L. Crane	Research Scientist Wright-Patterson Air Force Base Ohio 45433
Dr. Liberto de Pablo-Galan	Supervisor of Laboratories Bureau of Natural Resources Mexico City, Mexico
Dr. E. Christiaan de Wys	Department of Geology University of Denver Denver, Colorado 80210
Dr. Henry G. Fisk	Department of Geology Montana School of Mining and Technology Butte, Montana 59701

Dr. Dennis Foreman	Associate Professor Department of Dentistry The Ohio State University 43210
Mr. Thomas A. Geisler	Research Mineralogist Research and Development Department Lavino Division P.O. Box 29 Norristown, Pennsylvania 19404
Dr. Anthony L. Gentile	Head, Crystal Chemistry Section Hughes Research Labs Malibu, California
Dr. Peter J. Gielisse	Director, Division of Engineering Research and Development University of Rhode Island Kingston, Rhode Island 02881
Mr. Howard H. Hilderbrand	Mineralogist Battelle Memorial Institute Geneva, Switzerland
Miss Mary Elizabeth Kaley	California Research Corporation Box 543 Whittier, California 90605
Mr. Karl Kautz	Consultant 3734 West Vista Avenue Phoenix, Arizona 85021
Mr. Donald E. Koopman	X-ray Crystallographer National Cash Register Company Dayton, Ohio 45409
Mr. James L. Lager	326 Harrison Avenue Maumee, Ohio
Dr. Hsi-che Lin	Postdoctoral Fellow Queen's University Kingston, Ontario, Canada
Mr. James B. Lincoln	(U.S. Air Force, Officer Training School) 1610 Mansfield Port Huron, Michigan 48060
Mrs. Gloria King Ludlum	Editorial Staff Chemical Abstracts Service 2540 Olentangy River Road Columbus, Ohio 43202
Dr. Stephen R. Lyon	Research Scientist Wright-Patterson Air Force Base Ohio 45433
Dr. George McCormick	Assistant Professor Department of Geology University of Iowa Iowa City, Iowa 52240

Mr. Robert C. McGuire	Manager, Quality Control Jeffrey Mining Machinery Company Columbus, Ohio 43201
Dr. Taki Negas	Research Chemistry National Bureau of Standards Washington, D.C. 20234
Dr. Robert R. Ogilby	Chief Geologist General Refractories Company Philadelphia, Pennsylvania 19102
Dr. David Shi H. Quon	(Northern Electric Company) Box 647 Kanata, Ontario Canada
Dr. Robert R. Reeber	Assistant Professor Michigan State University East Lansing, Michigan 48823
Dr. Thomas J. Rockett	(American Hospital Association) 5 Gaywood Circle West Peabody, Massachusetts 01960
Dr. Robert A. Schoenlaub	Technical Director Edward Orton Jr. Ceramic Foundation 1445 Summit Street Columbus, Ohio 43201
Dr. Charles E. Semler, Jr.	Senior Research Chemist Monsanto Research Corporation Dayton Laboratory Dayton, Ohio 45407
Professor Robert E. Shanklin	Chairman, Department of Geology Ohio Wesleyan University Delaware, Ohio 43015
Mr. Robert F. Shurtz	(Bechtel Corporation) 1200 California Street, Apt. 5-D San Francisco, California 94109
Dr. Roland B. Snow	U.S. Steel Corporation Applied Research Laboratory Monroeville, Pennsylvania 15146
Miss Frances V. Stohl	School of Mineral Industries The Pennsylvania State University University Park, Pennsylvania 16802
Dr. Ronald J. Versic	GAF Corporation Binghamton, New York 13902

Dr. Ralph G. Wells	Crucible Steel Company Research Laboratory Box 988 Pittsburgh, Pennsylvania 15230
Dr. Robert E. Winchell	Associate Professor Department of Geology California State College at Long Beach Long Beach, California 90804
Mr. Seward E. Wooley	(Johns-Manville Products Comapny) 18 East Brown Street Somerville, New Yersey 08876
Mr. Truman W. Bennett	Ranney Water Systems, Inc. 926 East Broad Street Columbus, Ohio 43205
Mr. James H. Richardson	Materials Sciences Laboratory Aerospace Corporation El Segundo, California
Mrs. Barbara Thayer Scott	National Cash Register Company Dayton, Ohio
Mr. David V. Stiles	(Harbison-Walker Refractories Company) 151 Morrison Drive Pittsburgh, Pennsylvania 15216

The following Mineralogy graduates are recently deceased:

Dr. Helen Blair Barlett	(A.C. Spark Plug Division, General Motors Corporation, Flint, Michigan) Deceased July 25, 1969
Dr. E. Joseph Weiss	(Georgia Kaolin Company, Elizabeth, New Jersey) Deceased June 14, 1967

APPENDIX I

DEPARTMENT CHAIRMEN

William John McCaughey, Chairman.....1913 - 1952

Duncan McConnell, Chairman.....1952 - 1957

Wilfrid Raymond Foster, Chairman.....1957 - Present

APPENDIX II

FACULTY WITH OVER TWENTY YEARS OF SERVICE

William John McCaughey

Arthur Marshall Brant